

# Special Report: 50 Years of Immunization Success

Vaccines help prevent disease, and successful vaccination programs can lead to eradication of disease. As a result of vaccination efforts, smallpox no longer exists in the wild, polio has been eliminated in most countries, and endemic measles and rubella have been eliminated in the United States.

## Eradicating Smallpox

Smallpox is an acute contagious disease caused by variola virus, a member of the orthopoxvirus family. Believed to have originated over 3,000 years ago in India or Egypt, smallpox is one of the most devastating diseases known to humanity. For centuries, repeated epidemics swept across continents, decimating populations and changing the course of history. Eradication of smallpox, one of the crowning achievements of the 20<sup>th</sup> century, resulted from a concerted international effort that transcended political boundaries and ideology about disease treatment and prevention.

In 1789, Edward Jenner demonstrated that inoculation with cowpox could protect against smallpox: the first step in control of the disease had been taken. The inoculation of populations in England was subsequently widespread, and smallpox vaccination became mandatory in developed countries in the early 1900s. In 1967, when the World Health Organization (WHO) launched a comprehensive plan to eradicate smallpox, the “ancient scourge” threatened 60% of the world’s population, killed every fourth victim, scarred or blinded most survivors, and eluded any form of treatment. The vaccine had already been in use for some time, but in the early 1950s, 150 years after the introduction of vaccination, an estimated 50 million cases of smallpox still occurred in the world each year. When intensive international vaccination efforts

began, this morbidity figure fell by 1967 to around 10–15 million annual cases.

Through the global eradication campaign, smallpox was finally pushed back to the horn of Africa and then to a single last natural case, which occurred in Somalia in 1977. A fatal laboratory-acquired case occurred in the United Kingdom in 1978. The global eradication of smallpox was certified by a commission of eminent scientists in December 1979 and subsequently endorsed by the World Health Assembly in 1980.

Below: Drummers following their chief during a smallpox eradication ceremony in West Africa (1968).

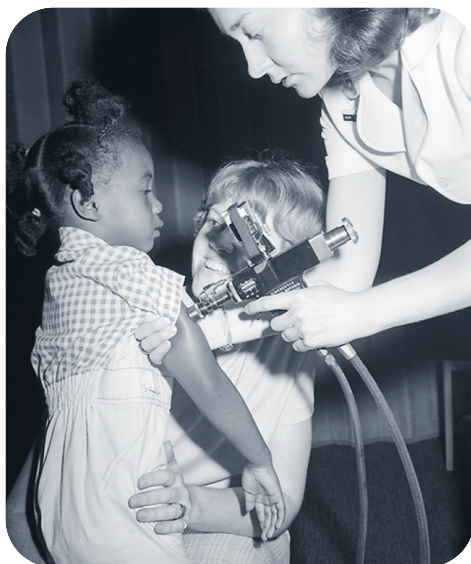


Right: People in Niger, West Africa awaiting a smallpox and measles vaccination (1969).



Left: Smallpox immunization team in Brazil (early 1960s).





A young child undergoing immunization with a jet injector at the Well-Baby Clinic in Dekalb County, Georgia, 1977.



Officers from the Epidemic Intelligence Service, EIS, Polio Team, during the Rhode Island Polio Epidemic of the 1960s.

## Controlling and Eliminating Polio

Poliomyelitis is an ancient disease, once widespread, that remains incurable. The disease strikes quickly and is not always properly diagnosed. Polio attacks the nerve cells of the spinal cord and sometimes the central nervous system, often causing paralysis and muscle wasting; it can even cause death. Since 1900 there had been cycles of epidemics in the U.S. Interest in a vaccine to prevent polio grew rapidly in the early 20<sup>th</sup> century. After the introduction of the vaccine, naturally occurring polio was eliminated in the U.S.

As a medical student and later a researcher at the University of Michigan, Jonas Salk studied viruses and ways to vaccinate against them. He was particularly interested in learning about the use of killed rather than attenuated viruses to produce vaccine, and he spent time researching influenza, a disease that had been especially virulent in the wake of World War I. Salk was eager to learn if the virus could be deprived of its ability to infect, while still giving immunity to the illness. Salk succeeded in this early attempt, which became the basis of his later work on polio.

In 1955 Salk's years of research paid off. Human trials proved his polio vaccine effectively protected against the virus. When news of the discovery was made public on April 12, 1955, Salk was hailed as a miracle worker. He further endeared himself to the public by refusing to patent the vaccine. He had no desire to profit personally from the discovery but merely wished to see the vaccine disseminated as widely as possible.

Salk's vaccine was composed of "killed" polio virus, which retained the ability to immunize without running the risk of infecting the patient. There was some evidence, however, that the "killed" vaccine failed to completely immunize. A few years later, a vaccine made from live polio virus was developed by Albert Sabin. This vaccine could be administered orally, was cheaper to produce, and seemed to guarantee immunization. In the U.S., public health authorities chose to distribute the "live" oral vaccine. It was discovered that, in rare cases, this vaccine can infect with the disease rather than immunize against it. Oral polio vaccine is no longer administered in the U.S.; since 2000, the U.S. has used an enhanced, more effective version of the original "killed" vaccine.



Billboards for "Stamp Out Polio" campaign U.S. 1963.

## Eliminating Endemic Measles and Rubella in the United States

### Eliminating Measles

Measles or rubeola is best known for its typical skin rash but is primarily a respiratory infection. Before immunization was available, measles occurred in springtime epidemics, usually in cycles of 2–3 years, with an average annual incidence of over 500,000 cases. Measles can lead to complications such as ear infections, croup, bronchitis, pneumonia, hepatitis, and encephalitis. Symptoms and complications of measles are usually most severe in adults.

Licensure of measles vaccine in 1963 was the first step toward elimination of measles in the United States. As a result of successful vaccination campaigns, cases in the Western Hemisphere have been reduced by over 99%. In 2000, measles was declared no longer endemic in the U.S., and from 1999–2003, worldwide measles-related deaths dropped 39%. However, measles remains the single leading cause of vaccine-preventable disease among children in Africa, and international efforts to eliminate measles in developing nations continue.

### Eliminating Rubella

Rubella or German measles, once a major cause of birth defects, has been eliminated in the U.S. While rubella may continue to be imported into the United States, immunization experts agree that rubella virus no longer circulates in the U.S. Consistent high vaccination rates protect against rubella. CDC's National Immunization Survey indicates that about 93% of children under age two residing in the U.S. are vaccinated against measles, mumps, and rubella; by age for school entry, more than 95% of children have been vaccinated with measles-mumps-rubella (MMR) vaccine.

### A History of Declining Cases Since Vaccination Began

In 1966, after the epidemic, annual reporting of rubella cases was instituted. Since that year, the largest number of total annual cases of rubella, 57,686 cases, was reported in 1969. Rubella vaccine was licensed in 1969, and a rubella vaccination program was developed to prevent rubella infection during pregnancy. Rubella incidence then fell rapidly, and by 1983 fewer than 1,000 cases were reported annually. Despite resurgence in rubella and measles cases during the measles epidemic of 1989–

1991, reported rubella cases dropped to all-time lows during the 1990s. From 1990 through 1999, only 117 cases of congenital rubella syndrome were reported, and 66 of those reported cases were for infants born in 1990 and 1991. In 2001, for the first time in history, fewer than 100 annual cases of rubella were reported in the U.S. In 2003, only 7 rubella cases and 1 case of congenital rubella syndrome were reported.

Since the mid-1990s, most reported cases of rubella in the United States have occurred among Hispanic young adults who were born in an area where rubella vaccine is not routinely administered. Since 1997, the majority of congenital rubella syndrome cases have occurred in children of unvaccinated Hispanic women, most born in Latin America. From the mid-1990s on, the U.S. has worked closely with the Pan American Health Organization (PAHO) and Mexico to improve rubella control in the Americas. As a result, rubella has declined dramatically in many nations of the Americas. To prevent a resurgence of rubella where it has been eliminated and to achieve overall elimination in the Americas, continued high vaccination rates among children and adults are essential.



## Impact of Vaccines on Polio and Rubella

Poliomyelitis	Pre-vaccine Average Annual Cases Reported	Pre-vaccine Average Annual Deaths Reported	Cases & Deaths Peak Year	2003 Cases Reported	2003 Deaths Reported	Vaccine Introduced
<b>“Acute” Poliomyelitis 1941–1950*</b>	17,299	1,336	Not available	No cases— 100% reduction	No deaths— 100% reduction	–First polio vaccine** (IPV), 1955 –Oral polio vaccine (OPV), <sup>^</sup> 1961–1963 –Enhanced IPV, 1987 <sup>^^</sup>
<b>“Paralytic” Poliomyelitis 1951–1954*</b>	16,316	1,884	In 1952, 21,269 cases, with 3,145 deaths	No cases— 100% reduction	No deaths— 100% reduction	
Rubella	Pre-vaccine Average Annual Cases Reported	Pre-vaccine Average Annual Deaths Reported	Cases & Deaths Peak Year	2003 Cases Reported	2003 Deaths Reported	Vaccine Introduced
<b>Acquired Rubella</b>	47,754	Not available	In 1964, 488,796 cases	7 cases— 99.9% reduction	No deaths— 100% reduction	Rubella vaccine introduced in 1969
<b>Congenital Rubella</b>	152	Not available	In 1964–1965, 20,000 cases with 2,160 deaths	1 case— 99.9% reduction	6 deaths in 2002 (latest available data)	

### Notes for Polio

\*Poliomyelitis cases were reported as “acute” until 1950; 1951–1980 poliomyelitis cases were reported as “total” or “paralytic.”

\*\*IPV is the inactivated polio vaccine or Salk vaccine; used routinely 1955–early 1960s.

<sup>^</sup>OPV is the oral polio vaccine; monovalent type 3 vaccine was licensed in 1961, monovalent type 1 and 2 in 1962, and trivalent vaccine in 1963. Trivalent OPV was used routinely 1963–1999.

<sup>^^</sup>eIPV is the enhanced inactivated polio vaccine, used exclusively since 2000.